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Micro-Double Triad Surfaces

Presently, micro-triad structures preferably consist of so-called single triads that correspond to trilateral pyramids and whose base is an equilateral or irregular triangle. Prismatic triads are used especially for producing light-reflecting surfaces. However, the shape of the trilateral single triad has a considerable portion of non-retro-reflected surface.

Now it has been shown how cube-shaped micro-prisms can be manufactured as triads with almost total reflection, but the cost of production is very high and increases at least inversely proportionately as a function of the diameter of the triad.

In addition, all prismatic triads possess three preferred directions opposite laterally incident light. To balance out these preferred directions, the triads can be arranged in such a manner that they are twisted with respect to each other around their respective rotational axes. But the production of these arrangements necessitate special production expenses to create reflective surfaces that are effective, under a wide angle, to more than three sides.

This utility patent shows a technically and economically simple mode of construction of triads that eliminates the restrictions of the familiar triad forms and is, above all, excellently suitable for the production of especially small micro structures.

Not only can the micro-double triad according to the invention be produced very economically, it also appears to be superior in its optical effect, compared to the other mentioned triad forms, because it acts, under a very wide angle, to six sides and to all sides of an open design as a cube-shaped triad prism.

Fig. 1 shows the micro-double triad viewed from above. Its cross-section corresponds to an equilateral hexagon. It has six partial surfaces 1-6 that form a hexagonal pyramid. The highest point of the pyramid is 7. If the micro-double triad is produced from light-transmitting material such as glass or plastic, it reflects the light that entered through the base surface of the pyramid. The retro-reflection takes place, in each case, by way of three partial surfaces--either 1, 3, and 5, or 2, 4, and 6.

Fig. 3 shows the two possible relationships of the partial surfaces to the retro-reflection, identified as 17 and 18.

Therefore, the micro-double triad actually consists of two triads fit into each other with a common rotational point (7). This triad form attains almost total reflection. The micro-double triad has six preferential directions for laterally incident light and is, thus, sufficiently wide-angled to all sides for practical applications--for instance, in traffic.

To produce micro-structures of this triad form, the additional insertion of single triads consisting of trilateral pyramids is required.

Fig. 2 shows the micro-double triad to which single triads are coordinated at two edges of its base surface. Each single triad corresponds, in its base surface, to 1/6 of the base surface of the micro-double triad. In Fig. 2, the micro-double triad and the two single triads combined form a rhombus.

If the surface of the rhombus was made up of 8 single triads whose non-reflecting surfaces amounted to about 25%, the non-reflecting surface in Fig. 2 would amount to only about 6.25 - 7%. However, this small non-reflecting surface is compensated for by the simple production possibility and the higher finishing accuracy that can be attained by it.

The first single triad possesses the partial surfaces (11, 12, and 13) with the pyramid tip (8) and the coinciding rotational axis (8). The second single triad possesses the partial surfaces (14, 15, and 16) with the pyramid top (9) and the coinciding rotational axis (9). In Fig. 3, the relationship of the partial triad surfaces to the retro-reflection are drawn in, whereas (19) and (20) show the reflection in the two single triads.

The rhombus consisting of the micro-double triad (25) and the two single triads (24 and 26) is represented in Fig. 4. The different triads are simply produced by cutting and/or grinding. For the sake of simplicity, only grinding will be mentioned in the following, but cutting by itself can already produce optically efficient triads.

To produce the micro-double triad surfaces, a work piece--e.g., a plate consisting of acrylic glass or brass--is notched in the desired angles, in three grinding directions (21, 22, and 23), whereby the three grinding directions are, in each case, consecutively turned under an angle of 60° (in example 4, anticlockwise).

The most important idea according to the invention is that the three grinding directions have such a course that always only two of them have a common point of intersection. If this rule were followed--therefore, if all three grinding directions were to have common points of intersection-- only undesirable simple triads would be generated.

To obtain a micro-double triad with equally large partial surfaces, it is necessary that the distances between the individual notches are equally large in each grinding direction.

A design of micro-double triads according to the invention develops so that each micro-double triad touches each of the surrounding six micro-double triads only at its common end point, and each micro-double triad touches the single triads at the edges they have in common.

Fig. 5 shows, in a lateral view, the tool (27) used for cutting or grinding--e.g., an accurately angled diamond that produces the notch (29) and thereby produces--simultaneously, in each case--a partial surface of the large micro-double triad (25) and a partial surface of the single triad (24). Line 28 shows the level of the notch depth.

Fig. 6 shows the course of the grinding direction (29) of Fig. 5 in a view from above.

Fig. 7 shows a group (30) of micro-double triads and single triads that, in this case, form an equilateral hexagon. Those kinds of groups of triads can be taken out of the surface--e.g., by cutting or stamping--in such a way that the ratio of the quantity of the micro-double triad to the quantity of the single triad is changed--e.g., that the ratio is no more than 1:2, as in Fig. 2, but that the number of single triads increases or decreases. In the example of Fig. 8, the groups of triads consist, in each case, of 7 micro-double triads and 12 single triads--therefore, a ratio of 7:12.

Fig. 8 shows, by way of example, the composition of the described groups (30). The individual groups touch at the separating lines (31).

During the grinding of the micro-double triad surfaces, the positive form emerges immediately when material such as, e.g., an acrylic glass plate is used. For spraying or stamping plastic or glass surfaces, a negative form is produced--e.g., galvanically--with which the desired micro-double triad surfaces can be stamped.

In their light-transmitting, transparent, or partially transparent form, the micro-double triad surfaces are not only suitable for retroflection of light but also as a diffusing lens of light when the angle of the partial surfaces of the triads are changed with respect to each other or when the direction of incidence of the light onto the micro-double triad surfaces is changed. For instance, lamp chimneys or lamp shells with a structure of micro-double triad surfaces can be used for scattering light.

Because of its large surface with a low overall height, the structure of the micro-double triad surfaces on bodies with the profile directed to the outside is suitable as a cooling surface (e.g., of electronic components) or for heat exchange on heat exchangers or heating elements--on the exterior surfaces as well as on the interior surfaces.

In bodies that are surrounded by media such as air, gas, or liquid, the micro-double triad surfaces directed outward can contribute considerably to the improvement of the flow behavior of the mentioned media.

By changing the surface design of high micro-double triads and low single triads, micro-whirls emerge between the mentioned triads that form a whirling layer on which the flowing media can glide along with a considerable reduction of the gliding resistance.

For instance, the micro-double triad surfaces can be used to improve the flow behavior on the exterior walls of ships, underwater vehicles, buoys, airplanes, and rockets or for shaping the inner surfaces of pipes. For this purpose, the micro-double triad surfaces can also be used in gas- and water turbines.

Patent claims

1. Micro-double triad surfaces, characterized in that the micro-double triad surfaces lie in the planes of, in each case, three grinding or cutting directions (21, 22, 23) that take a course in which always only two of them have a common point of intersection and in which the micro-double triads (254) formed in the process consist, in each case, of two triads with a common rotational point (7) whose total cross-section corresponds to an equilateral hexagon (Fig. 1), whereas the six partial surfaces of the micro-double triad are triangles and, together, form a hexagonal pyramid.

2. Micro-double triad surfaces according to claim 1, characterized in that the micro-double triad surfaces are produced from translucent or transparent plastic or glass.

3. Micro-double triad surfaces according to claim 1 or 2, characterized in that two simple triads (24) and (26) are associated with each micro-double triad (25) so that each simple triad corresponds with a trilateral pyramid and--in the size of its base surface--corresponds with 1/6 of the base surface of the adjacent micro-double triad.

4. Micro-double triad surfaces according to claim 3, characterized in that each micro-double triad touches each of the surrounding six micro-double triads only at a common corner point and touches the single triads at one side.

5. Micro-double triad surfaces according to claim 1-4, characterized in that the cutting or grinding directions (21, 22, 23) of the planes of the micro-double surfaces follow after one another, in each case, under an angle of 60°C.

6. Micro-double triad surfaces according to claims 1-5, characterized in that the micro-double triad surfaces are windable foils, sheets, leaves, labels, and/or cut or punched parts of the same.

7. Micro-double triad surfaces according to claim 1-5, characterized in that the micro-double triad surfaces are molded articles or plates, the cut or stamped parts of the mentioned molded bodies, sheets, foils, and/or plates.

8. Micro-double triad surfaces according to one or several of the preceding claims, characterized in that the micro-double triad surfaces are metallized by evaporation of metal such as aluminum, copper, silver, or gold, and/or their compounds, or lacquered with earths such as titanium oxide.

9. Micro-double surfaces according to one or several of the preceding claims, characterized in that the micro-double triad surfaces are combined in groups of equal size (Fig. 8) and are formed by a combination of micro-double triads and simple triads.

10. Micro-double triad surfaces according to one or several of the preceding claims, characterized in that, on the profiled side, the micro-double triad surfaces are covered air tight and water tight with a frame or a cover foil and are provided with glue and welding seams at the edges and/or distributed at regular or irregular intervals over the micro-double surfaces, while the welding or glue seams produce a screen.

11. Micro-double surfaces according to claims 9 and 10, characterized in that the welding or glue seams between the profiled side of the micro-double surfaces and the cover by the frame or cover film follow the separating lines (31) between the groups of triads.

12. Micro-double triad surfaces according to one or several of the preceding claims, characterized in that the profiled side of the micro-double triad surfaces is dipped into a liquid, pasty, or gaseous medium.